



# Lakewatch

*The Alberta Lake Management Society  
Volunteer Lake Monitoring Program*

Pine Lake

2017

Updated May 11, 2021

Lakewatch is made possible  
with support from:



Helping  
the world  
thrive



Lakeland Industry &  
Community Association



Beaver River  
Watershed Alliance



Environment  
and Parks

# ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch Reports are designed to summarize basic lake data in understandable terms for a lay audience and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in LakeWatch and readers requiring more information are encouraged to seek those sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at [info@alms.ca](mailto:info@alms.ca).

## ACKNOWLEDGEMENTS

The LakeWatch program is made possible through the dedication of its volunteers. We would like to extend a special thanks to Ed Lawrence for the time and energy put into sampling Pine Lake in 2017. We would also like to thank Elashia Young and Melissa Risto who were summer technicians in 2017. Executive Director Bradley Peter and LakeWatch Coordinator Laura Redmond was instrumental in planning and organizing the field program. This report was prepared by Laura Redmond and Bradley Peter. The Beaver River Watershed, the Red Deer River Watershed Alliance, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

## PINE LAKE

Pine Lake is a small eutrophic lake southeast of Red Deer, Alberta. Pine Lake is subject to cyanobacterial blooms and public concern over deteriorating water quality prompted the Alberta government to initiate a lake restoration program in 1991. The Pine Lake Restoration Program was designed as a pilot project for future lake and watershed projects in Alberta.



Pine Lake—photo by Jessica 2011

An advisory committee that represented all members of the community directed early planning and problem diagnosis by the Alberta government. A diagnostic study in 1992 determined that approximately 61% of the total phosphorus (TP) loading was from sediment release and other internal sources, while about 36% was from surface runoff. Monitoring of Pine Lake determined that algal growth was mainly limited by the supply of phosphorus<sup>1</sup>. Four critical areas for watershed restoration were identified on four streams affected by livestock operations and sewage release. These streams contributed 72% of the phosphorus loading in 1992.

The advisory committee later formed the Pine Lake Restoration Society, a non-profit organization with representatives from all stakeholders which raised funds and worked with technical advisors from the Alberta government. The Pine Lake Restoration Society implemented a four-year work plan in 1995 that addressed phosphorus loading from all sources. The main objective of the restoration program was to restore Pine Lake to a 'natural' level of algal productivity (as determined by paleolimnology). The Pine Lake Restoration Society and other individuals in the basin completed beneficial management practice (BMP) projects at various agricultural sites. Other organizations also improved wastewater treatment at a resort and two camps near the shoreline of Pine Lake.

Following an evaluation of the different alternatives to remove or treat phosphorus released from lake sediments, hypolimnetic withdrawal was selected as the preferred method of treatment. Hypolimnetic withdrawal has been successfully used to reduce TP concentration in various lakes, mainly in Europe, but had never been attempted in Alberta. The hypolimnetic withdrawal system at Pine Lake, installed in 1998, consists of a weir that regulates lake levels, and a gravity-fed pipeline that withdraws cool, phosphorus-rich water from near the bottom of the lake (the hypolimnion) of the south basin and discharges it through a vault with control valves to a stilling basin on Ghostpine Creek.

<sup>1</sup> Sosiak, A. J and Trew, D.O. (1996). Pine Lake restoration project. Diagnostic Study (1992). Obtained from: <http://environment.gov.ab.ca/info/library/7764.pdf>



## METHODS

**Profiles:** Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5- 1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

**Composite samples:** At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Maxxam Analytics, chlorophyll-*a* and metals are analyzed by Alberta Innovates Technology Futures (AITF), and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

**Invasive Species:** Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

**Data Storage and Analysis:** Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at [aep.alberta.ca/water](http://aep.alberta.ca/water).

Data analysis is done using the program R.<sup>1</sup> Data is reconfigured using packages tidyr<sup>2</sup> and dplyr<sup>3</sup> and figures are produced using the package ggplot2<sup>4</sup>. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)<sup>5</sup>. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between TP, chlorophyll-*a*, TKN and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship. For lakes with >10 years of long term data, trend analysis is done with nonparametric methods. The seasonal Kendall test estimates the presence of monotonic (unidirectional) trends across individual seasons (months) and is summed to give an overall trend over time. For lakes that had multiple samplings in a single month, the value closest to the middle of the month was used in analysis.

---

<sup>1</sup> R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

<sup>2</sup> Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. <https://CRAN.R-project.org/package=tidyr>.

<sup>3</sup> Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. <http://CRAN.R-project.org/package=dplyr>.

<sup>4</sup> Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

<sup>5</sup> Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

BEFORE READING THIS REPORT, CHECK  
OUT [A BRIEF INTRODUCTION TO  
LIMNOLOGY](#) AT [ALMS.CA/REPORTS](#)

## WATER CHEMISTRY

*ALMS measures a suite of water chemistry parameters. Phosphorus, nitrogen, and chlorophyll-*a* are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are Microcystins, a common group of toxins produced by cyanobacteria. See Table 2 for a complete list of parameters.*

The average total phosphorus (TP) concentration for Pine Lake was 78.8 µg/L (Table 2), falling into the eutrophic, or productive, trophic classification. This value falls well within the range of historical averages. TP was relatively stable over the course of the sampling season (Figure 1).

Average chlorophyll-*a* concentration in 2017 was 38.0 µg/L (Table 2), putting Pine Lake into the hypereutrophic, or very productive classification. This is the highest average concentration of chlorophyll-*a* measured since 1992. Chlorophyll-*a* peaked on August 30, measuring 53.2 µg/L (Figure 1).

Finally, average TKN concentration was 1.9 mg/L (Table 2). TKN concentrations varied throughout the sampling season, peaking on August 30. Chlorophyll-*a* and TKN were positively correlated, but this trend was not significant ( $r = 0.86$ ,  $p = 0.06$ ).

Average pH was measured as 8.77 in 2017, buffered by moderate alkalinity (312 mg/L CaCO<sub>3</sub>) and bicarbonate (336 mg/L HCO<sub>3</sub>). Sodium and sulphate were the dominant ions contributing to a moderate conductivity of 742 µS/cm (Table 2).

## METALS

*Samples were analyzed for metals (Table 3). In total, 27 metals were sampled for. It should be noted that many metals are naturally present in aquatic environments due to the weathering of rocks and may only become toxic at higher levels.*

Metals were measured on August 30 at Pine Lake at the surface. Arsenic was measured as above the recommended guideline measuring 7.11 µg/L. Copper and selenium also exceeded the recommended guideline. Historically, no metals have exceeded guidelines at Pine Lake. In 2017, all other measured values fell within their respective guidelines (Table 3).

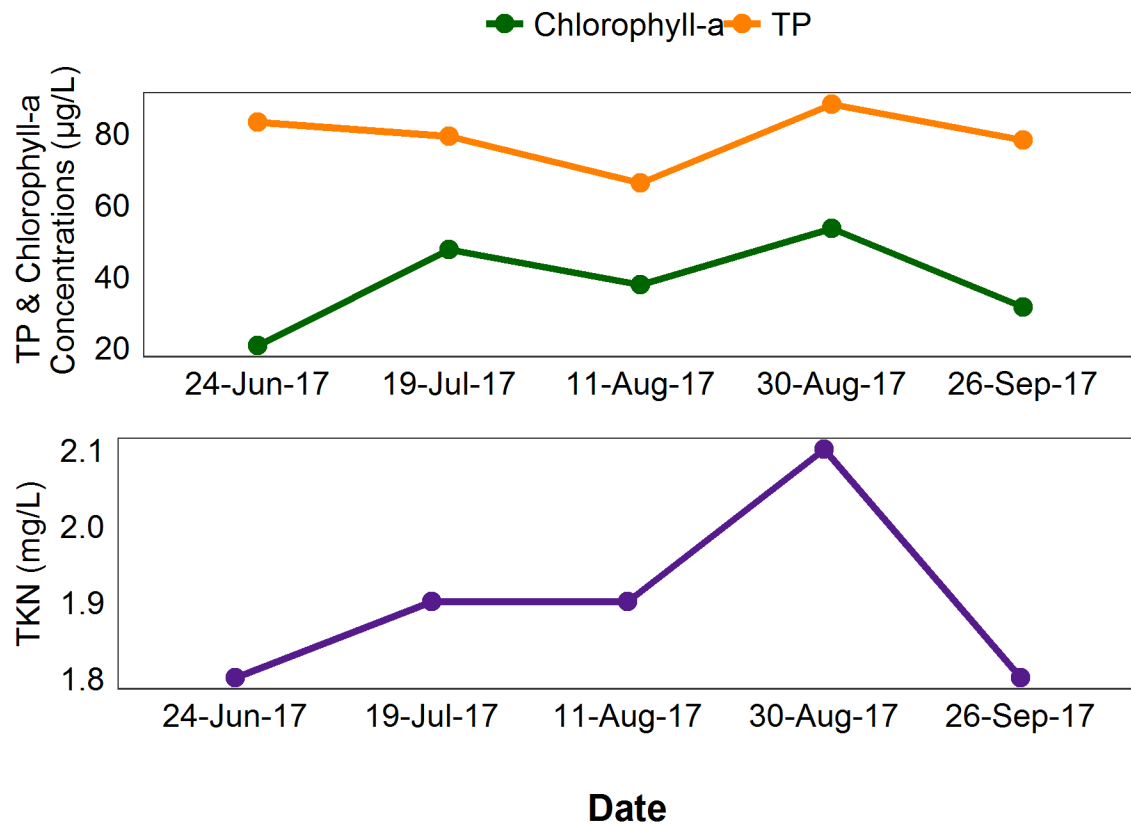


Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured five times over the course of the summer at Pine Lake.

## WATER CLARITY AND SECCHI DEPTH

*Water clarity is influenced by suspended materials, both living and dead, as well as dissolved colored compounds in the water column. During the melting of snow and ice in spring, lake water can become turbid (cloudy) from silt transported into the lake. Lake water usually clears in late spring but then becomes more turbid with increased algal growth as the summer progresses. The easiest and most widely used measure of lake water clarity is the Secchi depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.*

The average Secchi depth of Pine Lake in 2017 was 1.4 m (Table 2). Water clarity measured as Secchi depth was highest on June 24, and decreased to around 1 m for the remainder of the season. Secchi disk depth was negatively associated with chlorophyll-*a* ( $r = -0.9$ ,  $p = 0.04$ ). The decreasing water clarity could therefore be associated with increasing algae biomass in the warmer months of the summer.

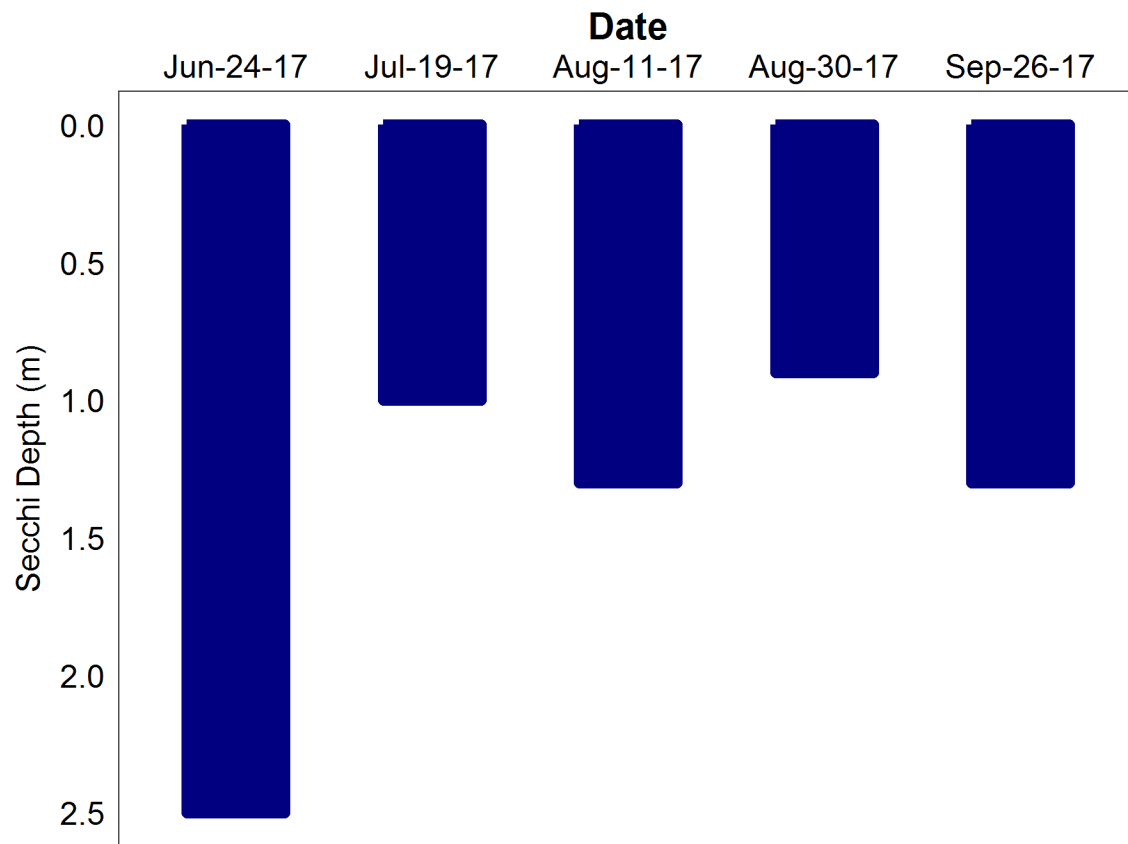


Figure 2 – Secchi depth values measured five times over the course of the summer at Pine Lake in 2017.

## WATER TEMPERATURE AND DISSOLVED OXYGEN

*Water temperature and dissolved oxygen profiles in the water column can provide information on water quality and fish habitat. The depth of the thermocline is important in determining the depth to which dissolved oxygen from the surface can be mixed. Please refer to the end of this report for descriptions of technical terms.*

Temperatures of Pine Lake varied throughout the summer, with a maximum temperature of 21.3 °C measured at the surface on August 11 (Figure 3a). Pine Lake was weakly thermally stratified on July 19 and August 11. By September 26, the entire water column was around 12 °C.

Pine Lake remained well oxygenated at the surface throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). During thermal stratification, oxygen levels decreased near the bottom because it is cut off from atmospheric oxygen that is circulated at the water surface. Decreasing dissolved oxygen near the bottom on August 30 may also be associated with decomposition.

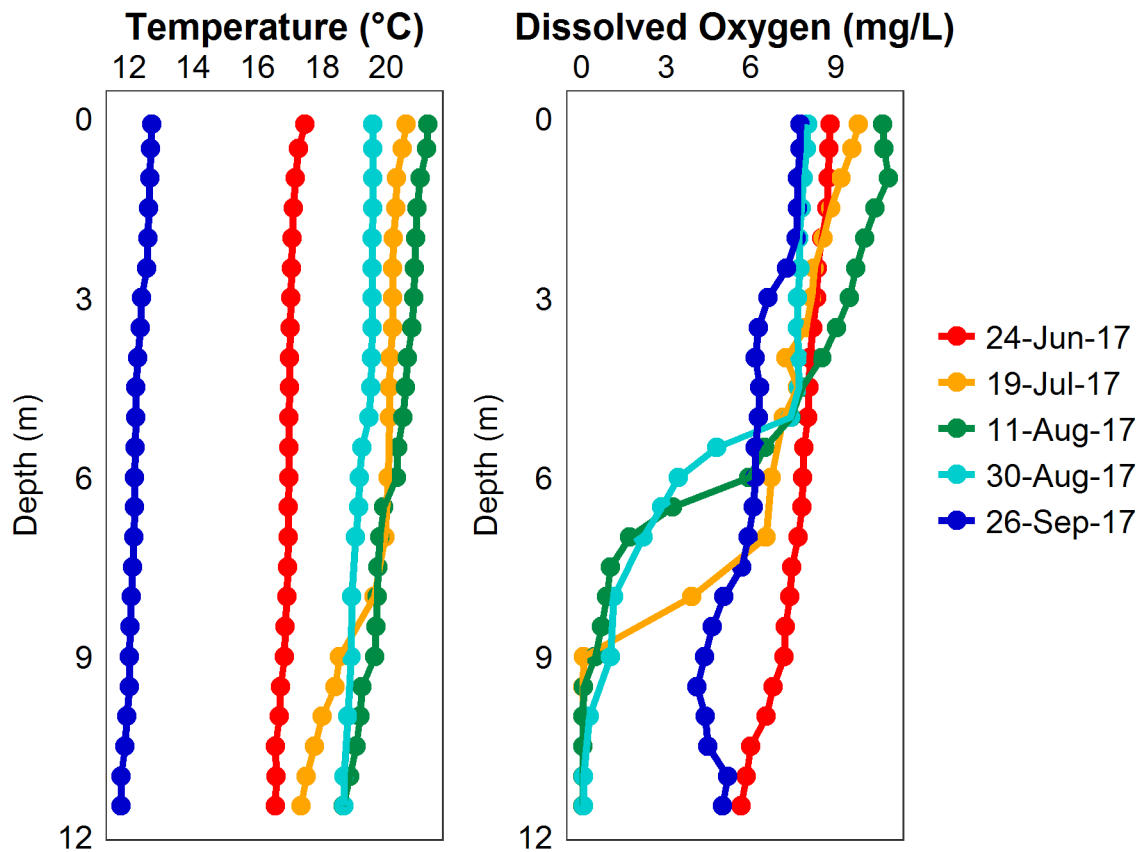


Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Pine Lake measured five times over the course of the summer of 2017.

## MICROCYSTIN

*Microcystins are toxins produced by cyanobacteria (blue-green algae) which, when ingested, can cause severe liver damage. Microcystins are produced by many species of cyanobacteria which are common to Alberta's Lakes, and are thought to be the one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 µg/L. Blue-green algae advisories are managed by Alberta Health Services. Recreating in algal blooms, even if microcystin concentrations are not above guidelines, is not recommended.*

Microcystin levels in Pine Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1).



Table 1 – Microcystin concentrations measured five times at Pine Lake in 2017.

Date	Microcystin Concentration (µg/L)
Jun-24-17	0.85
Jul-19-17	1.97
Aug-11-17	2.82
Aug-30-17	3.2
Sep-26-17	2.43
Average	2.25

## INVASIVE SPECIES MONITORING

*Dreissenid mussels pose a significant concern for Alberta because they impair the function of water conveyance infrastructure and adversely impact the aquatic environment. These invasive mussels have been linked to creating toxic algae blooms, decreasing the amount of nutrients needed for fish and other native species, and causing millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities.*

Monitoring involved two components: monitoring for juvenile mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Pine Lake since invasive species monitoring began in 2013.

## WATER LEVELS

*There are many factors influencing water quantity. Some of these factors include the size of the lake's drainage basin, precipitation, evaporation, water consumption, ground water influences, and the efficiency of the outlet channel structure at removing water from the lake. Requests for water quantity monitoring should go through Alberta Environment and Parks Monitoring and Science division.*

Pine Lake water levels have been monitored by volunteers along with Alberta Environment since 2007 and have fluctuated within less than half a metre in this time. Pine Lake water levels are controlled by a weir system.

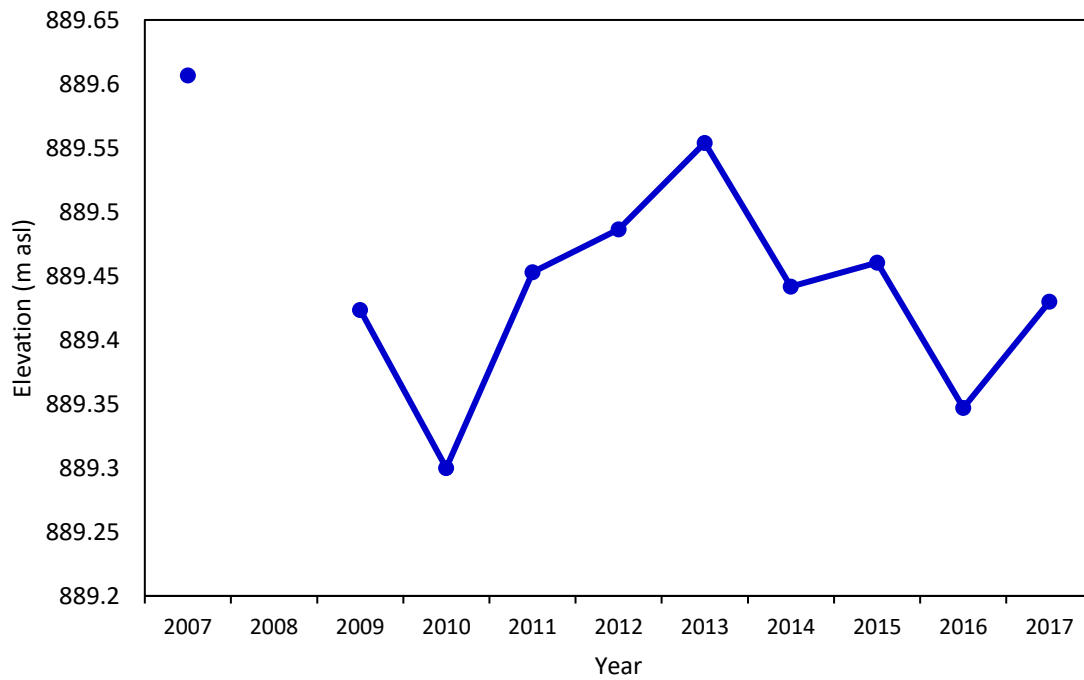


Figure 4- Average yearly water levels measured in metres above sea level (m asl) from 2007-2017. Data retrieved from Alberta Environment and Parks.

Table 2: Average Secchi depth and water chemistry values for Pine Lake. Historical values are given as reference.

Parameter	1979	1984	1992	1996	2002	2003	2004	2005	2006	2008	2009	2011	2013	2015	2017
TP (µg/L)	/	56	84.7	104	49.3	55	79	70	81.2	78.8	68	92.8	72.75	69	78.8
TDP (µg/L)	/	/	38.6	57.9	18.4	26.2	26.2	33.3	32.4	33.8	34.5	31.4	42.25	30	24.6
Chlorophyll- <i>a</i> (µg/L)	11.3	26.3	50.4	22.1	15.6	17.9	37.8	19.3	32.7	37.2	22.5	30.8	17.82	26.7	38.0
Secchi depth (m)	3.4	1.8	1.8	2.1	1.7	3.1	1.7	2.5	1.8	1.2	1.86	1.29	1.94	1.75	1.4
TKN (mg/L)	1.3	1.3	2.1	1.4	1.4	1.5	1.9	1.8	1.9	1.9	1.8	1.9	1.7	2.9*	1.9
NO <sub>2</sub> -N and NO <sub>3</sub> -N (µg/L)	13	<10	36	11	3	10	9.7	11	2	13	15.5	6.2	8.625	4.4	7.02
NH <sub>3</sub> -N (µg/L)	/	59	146	120	11	98	136	156	134	135	65	134	81.75	62.3	83.6
DOC (mg/L)	/	/	/	/	/	/	22.3	17.3	18.8	17.3	17.8	18.7	17.8	17	19
Ca (mg/L)	/	23	25	28	20	21	21.7	21	24	29.1	27.3	31.2	31	26	29.2
Mg (mg/L)	/	25	25	24	26	24	25	23	23	23.5	24.3	23.3	26.2	28	28.4
Na (mg/L)	/	108	99	103	112	124	132	129	128	109	115.3	83.6	90.45	95	110
K (mg/L)	/	10	9	10	11.5	10	10	10	10.7	9.7	10.4	9.1	8.65	8.8	9.78
SO <sub>4</sub> <sup>2-</sup> (mg/L)	/	84	69	63	90	79	85	78	82.3	68.3	75.6	56	62.5	70	69.6
Cl <sup>-</sup> (mg/L)	/	6	7	8	11	10	11	10	12	12.8	13.46	12.4	11.85	15	16.2
CO <sub>3</sub> (mg/L)	/	/	/	/	/	22.8	20.5	17.7	17	9.7	14.3	11.3	16.67	21	21.6
HCO <sub>3</sub> (mg/L)	/	/	/	/	/	/	374	381	387	370	371.6	334	331.75	315	336
pH	/	/	/	/	/	/	8.8	8.7	8.7	8.5	8.61	8.6	8.63	8.81	8.77
Conductivity (µS/cm)	/	/	/	/	/	/	787.75	764	786	729.3	754.7	659	697.25	690	742
Hardness (mg/L)	/	/	/	/	/	163	156	148.3	153.3	169.6	168	174	185	178	192
TDS (mg/L)	/	/	/	/	/	469	489	477.3	487.3	457.6	463.6	393	408.5	418	452
Microcystin (µg/L)	/	/	/	/	/	/	/	0.876	0.2925	0.4275	1.19	0.27		2.51	2.25
Total Alkalinity (mg/L CaCO <sub>3</sub> )	/	319	308	313	321	331	341	342	346	319.7	328.3	293	293.25	295	312

Table 3: Concentrations of metals measured in Pine Lake. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	2003	2004	2013	2015	2017	Guidelines
Aluminum µg/L	24.9	30.55	26.2	49.15	97.1	100 <sup>a</sup>
Antimony µg/L	0.057	0.078	0.0915	0.0955	0.52	/
Arsenic µg/L	1.14	1.145	1.37	1.395	7.11	5
Barium µg/L	56.2	58.6	59.7	52.2	298	/
Beryllium µg/L	0.17	0.00225	0.0015	0.006	0.0055	100 <sup>c,d</sup>
Bismuth µg/L	0.0065	0.00115	0.115	0.031	0.0055	/
Boron µg/L	67.7	80.3	85.8	89.8	469	1500
Cadmium µg/L	0.01	0.0037	0.0039	0.0085	0.025	0.26 <sup>b</sup>
Chromium µg/L	0.36	0.334	0.402	0.615	0.25	/
Cobalt µg/L	0.065	0.063	0.115	0.12	0.641	1000 <sup>d</sup>
Copper µg/L	0.83	1.57	0.468	1.265	4.29	4 <sup>b</sup>
Iron µg/L	/	9	36.2	47.7	105	300
Lead µg/L	0.165	0.12665	0.0544	0.0945	0.165	7 <sup>b</sup>
Lithium µg/L	34.8	43.55	35.5	38	196	2500 <sup>e</sup>
Manganese µg/L	10.86	10.475	7.42	12.8	66.4	200 <sup>e</sup>
Molybdenum µg/L	0.68	0.7	0.835	0.923	5.06	73 <sup>c</sup>
Nickel µg/L	0.045	0.195	0.527	0.5595	2.38	150 <sup>b</sup>
Selenium µg/L	0.35	0.05	0.177	0.15	2.3	1
Silver µg/L	0.0025	0.00025	0.0277	0.004	0.01	0.25
Strontium µg/L	255.67	283.5	284	264	1420	/
Thallium µg/L	0.033	0.0007	0.0005	0.0052	0.016	0.8
Thorium µg/L	0.0015	0.00555	0.0966	0.1132	0.083	/
Tin µg/L	0.05	0.015	0.0352	0.0365	0.15	/
Titanium µg/L	1.7	1.32	0.95	1.795	4.7	/
Uranium µg/L	0.71	0.7565	1.25	1.27	6.38	15
Vanadium µg/L	0.397	0.3755	0.573	0.655	2.95	100 <sup>d,e</sup>
Zinc µg/L	4.36	7.69	0.772	0.85	3.3	30

Values represent means of total recoverable metal concentrations.

<sup>a</sup> Based on pH ≥ 6.5

<sup>b</sup> Based on water hardness > 180mg/L (as CaCO<sub>3</sub>)

<sup>c</sup> CCME interim value.

<sup>d</sup> Based on CCME Guidelines for Agricultural use (Livestock Watering).

<sup>e</sup> Based on CCME Guidelines for Agricultural Use (Irrigation).

A forward slash (/) indicates an absence of data or guidelines.

## LONG TERM TRENDS

Trend analysis was conducted on the parameters total phosphorus (TP), chlorophyll-*a*, total dissolved solids (TDS) and Secchi depth to look for changes over time in Pine Lake. In sum, non-significant increases were observed in chlorophyll-*a* and significant increasing trends were observed in TP. Significant decreases were observed in TDS and Secchi depth. Secchi depth can be subjective and is sensitive to variation in weather - trend analysis must be interpreted with caution. Data is presented below as both a line graph (all data points used in analysis) and a box-and-whisker plot. Detailed methods are available in the *ALMS Guide to Trend Analysis on Alberta Lakes*.

Table 1: Summary table of trend analysis on Pine Lake data from 2003 to 2017.

Parameter	Date Range	Trend	Probability
Total Phosphorus	2003-2017	Increasing	Significant
Chlorophyll- <i>a</i>	2003-2017	Increasing	Non-significant
Total Dissolved Solids	2003-2017	Decreasing	Significant
Secchi Depth	2003-2017	Decreasing	Significant

### Definitions:

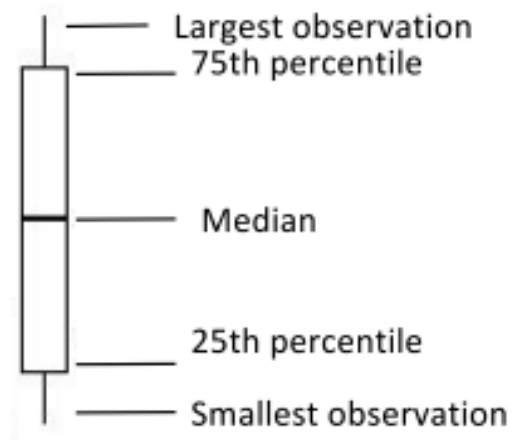
**Median:** the value in a range of ordered numbers that falls in the middle.

**Trend:** a general direction in which something is changing.

**Monotonic trend:** a gradual change in a single direction.

**Statistically significant:** The likelihood that a relationship between variables is caused by something other than random chance. This is indicated by a *p*-value of <0.05. **Variability:** the extent by which data is inconsistent or scattered.

**Box and Whisker Plot:** a box-and-whisker plot, or boxplot, is a way of displaying all of our annual data. The median splits the data in half. The 75<sup>th</sup> percentile is the upper quartile of the data, and the 25<sup>th</sup> percentile is the lower quartile of the data. The top and bottom points are the largest and smallest observations.





## Total Phosphorus (TP)

Since 2003, TP has significantly increased (Tau= -0.32,  $p = 0.013$ ).

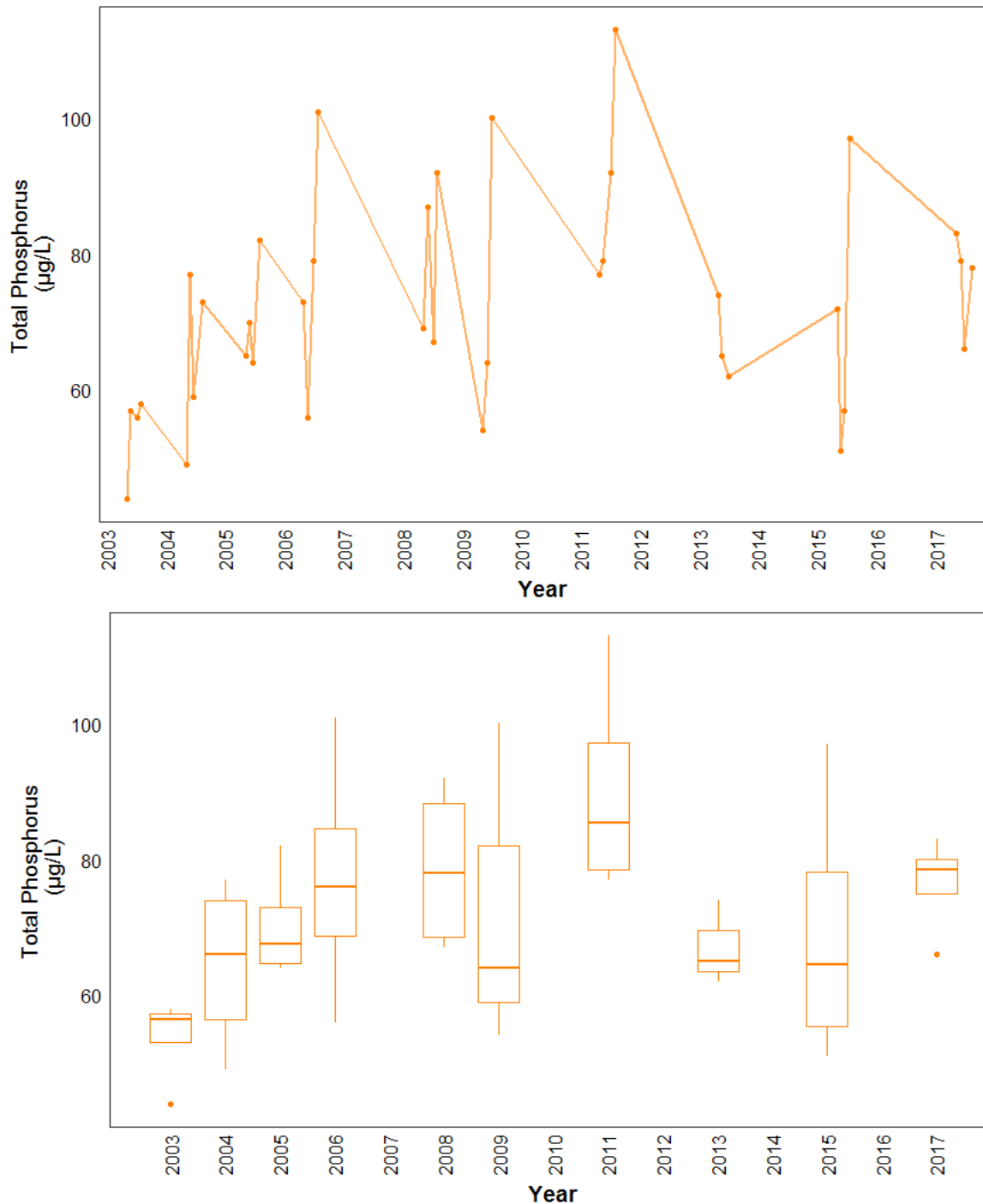


Figure 1-Monthly total phosphorus (TP) concentrations measured between June and September over the long term sampling dates between 2003 and 2017 ( $n = 38$ ). The value closest to the 15<sup>th</sup> day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

## Chlorophyll-*a*

Chlorophyll-*a* has not significantly changed in Pine Lake since 2003 (Tau = 0.32,  $p = 0.115$ ). Chlorophyll-*a* is moderately correlated with TP ( $r = 0.55$ ,  $p = 0.0004$ ).

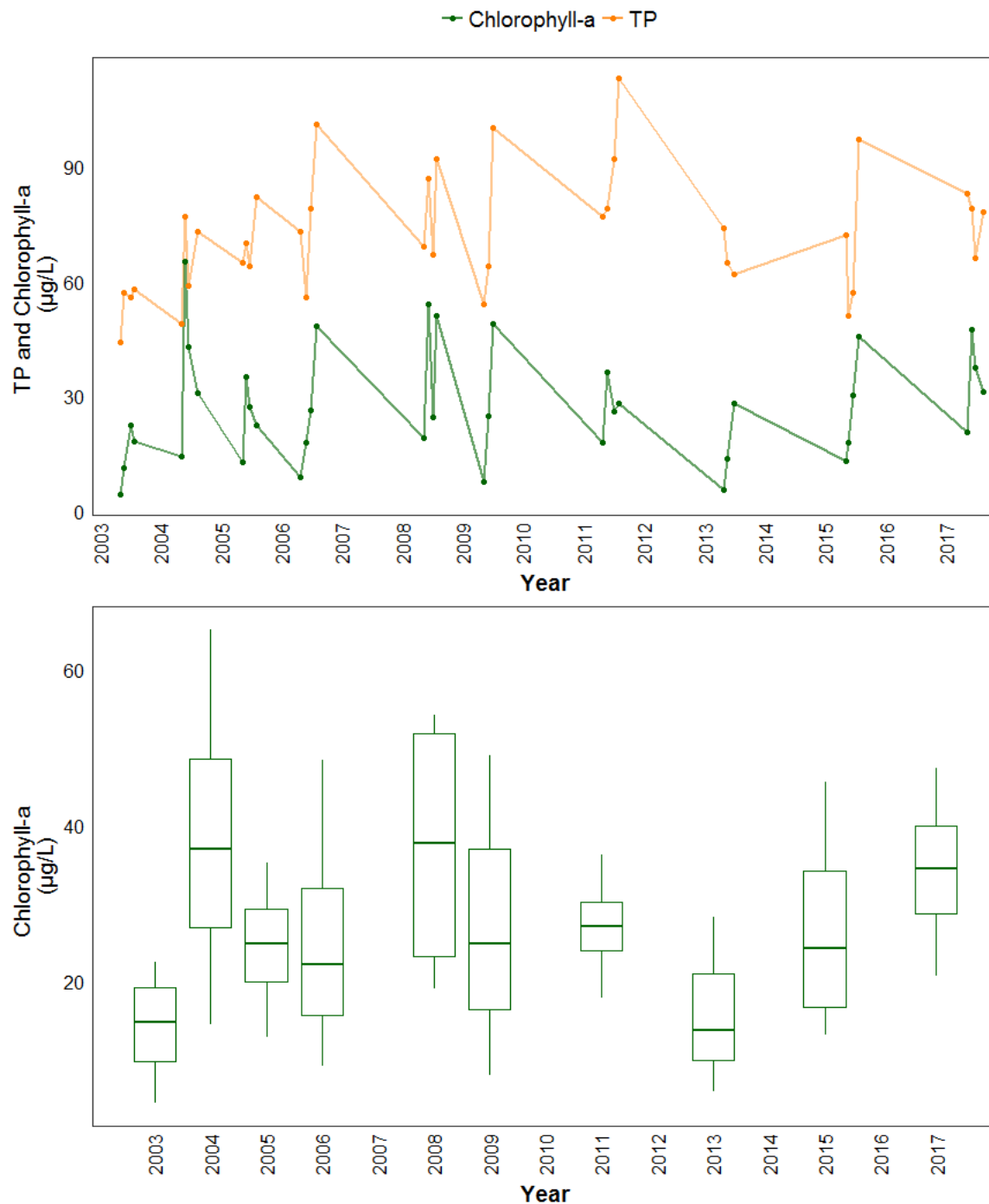


Figure 2-Monthly chlorophyll-*a* concentrations measured between June and September over the long term sampling dates between 2003 and 2017 ( $n = 38$ ). The value closest to the 15<sup>th</sup> day of the month was chosen to represent the monthly value in cases with multiple monthly samples. Line graph is overlain by TP concentrations.

## Total Dissolved Solids (TDS)

TDS has significantly decreased in Pine Lake (Tau = -0.46,  $p = 0.003$ ).

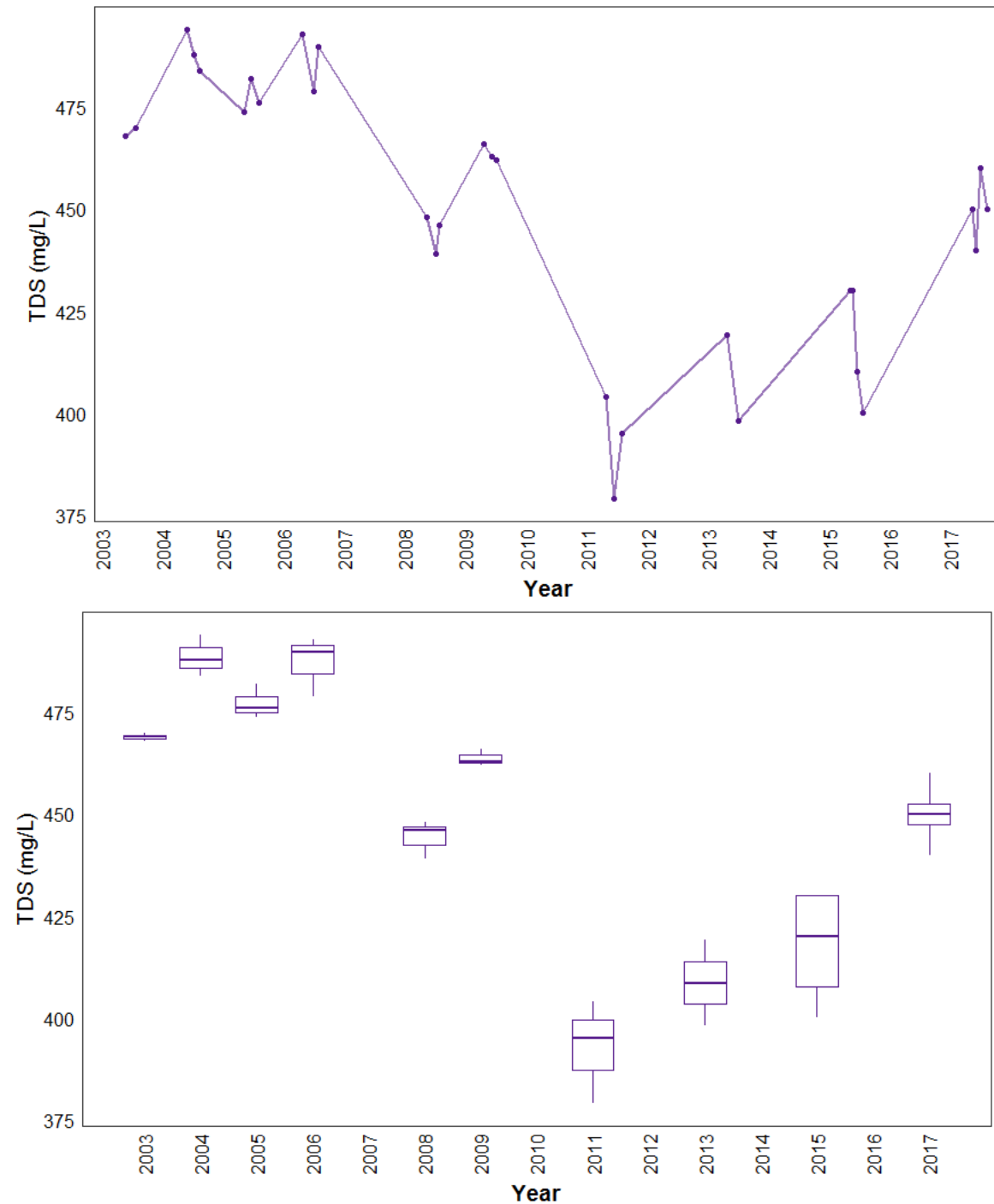


Figure 3-Monthly TDS concentrations (mg/L) measured between June and September over the long term sampling dates between 2003 and 2017 (n = 30). The value closest to the 15<sup>th</sup> day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

## Secchi Depth

Water clarity has decreased significantly in Pine Lake since 2003 (Tau = -0.34,  $p = 0.009$ ).

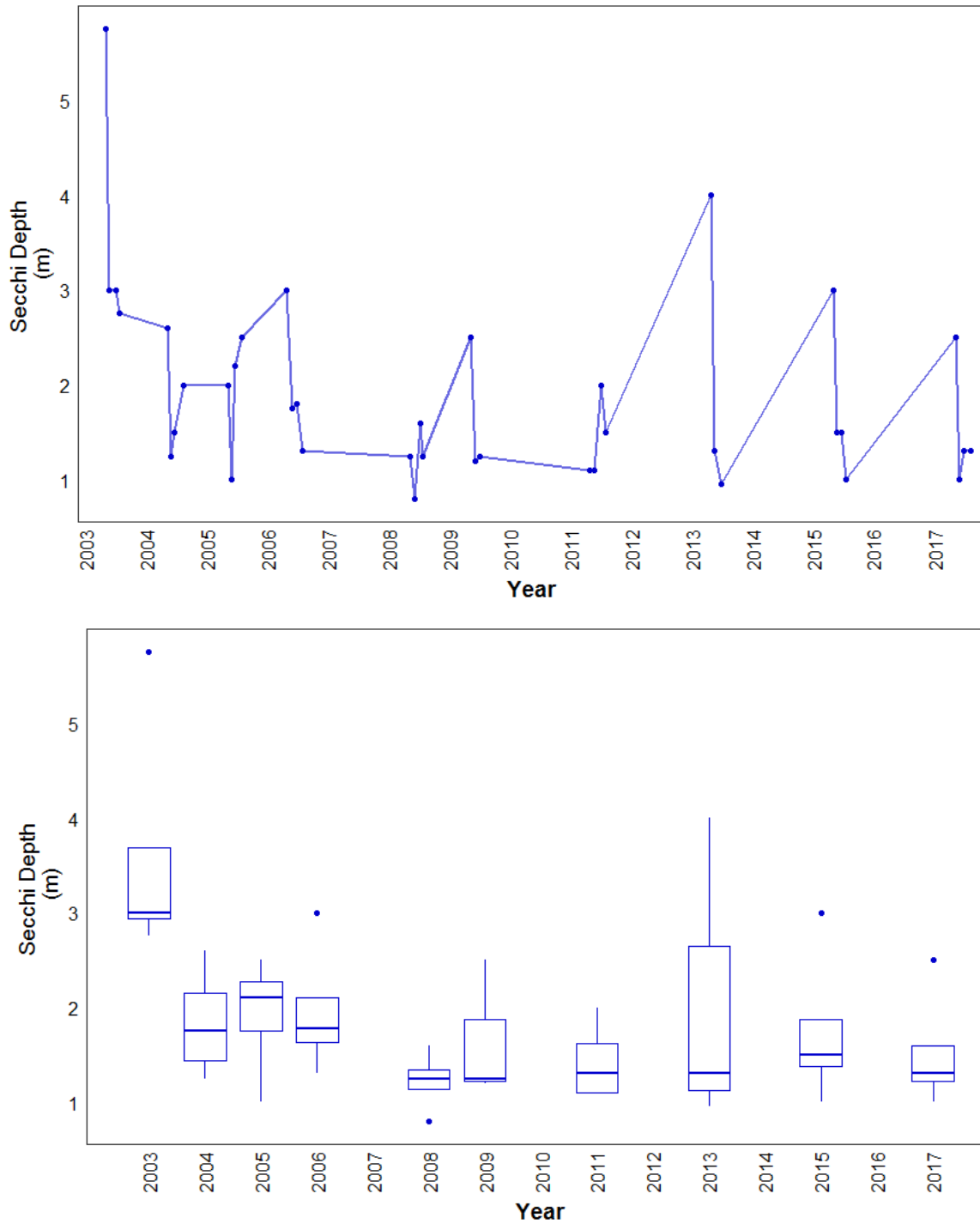


Figure 4-Monthly Secchi depth values measured between June and September over the long term sampling dates between 2003 and 2017 ( $n = 38$ ). The value closest to the 15<sup>th</sup> day of the month was chosen to represent the monthly value in cases with multiple monthly samples.

Table 2- Results of Seasonal Kendall and Mann-Kendall Trend tests using monthly total phosphorus (TP), chlorophyll-*a*, total dissolved solids (TDS) and Secchi depth data from June to September on Pine Lake data.

Definition	Unit	Total Phosphorus (TP)	Chlorophyll-a	Total Dissolved Solids (TDS)	Secchi Depth
Statistical Method	-	Seasonal Kendall	Seasonal Kendall	Seasonal Kendall	Seasonal Kendall
The strength and direction (+ or -) of the trend between 0 and 1	Tau	0.32	0.22	-0.46	-0.36
The extent of the trend	Slope	1.29	0.50	-4.8	-0.067
The statistic used to find significance of the trend	Z	2.48	1.57	-3.00	-2.70
Number of samples included	n	38	38	30	38
The significance of the trend	<i>p</i>	0.013*	0.115	0.003*	0.007*

\**p* < 0.05 is significant within 95%